日本古生物学會
報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series No. 11

日本古生物學會
Palaeontological Society of Japan
September 30, 1953

CONTENTS

TRANSACTIONS

All Communications relating to this Journal should be addressed to the

PALAEONTOLOGICAL SOCIETY OF JAPAN

Geological Institute, Faculity of Science, University of Tokyo, Japan

Trans. Proc. Palaeont. Soc. Japan, N.S. No. 11, pp. 55—59, 11 text-figs., Sept. 30, 1953

234. MIOCENE FORAMINIFERA FROM THE HONYA SHALE, JÔBAN COAL-FIELD*

KIYOSHI ASANO

Contribution from the Institute of Geology and Paleontology, Tôhoku University

常磐炭田本谷頁岩の有孔虫化石：平市矢川瀬附近及び江名町江名附近の本谷頁岩中に含まれる有孔虫化石を研究し，前者のところではボーリングの資料も参照し古生態を論じた。有孔虫化石よりみた地質時代は，裏日本の黒色頁岩と対比されること及びアメリカ北西海岸地域の中部中新世に相当するものが多いことから，中新世中部と考えられる。浅　野　　清

Introduction

The foraminiferal fauna discussed herein was collected from the Miocene Honya shale of the Yunagaya group by Mr. Y. KAMADA of the Institute of Geology and Paleontology, Tôhoku University during his geological survey of the Taira-Ena district, Fukushima Prefecture.

The fauna is of interest from the standpoint of correlation between the Tertiary formations of the Pacific and Japan Sea coastal areas of Northern Japan.

Here, the writer expresses his cordial thanks to Mr. Yasuhiko KAMADA for submitting his collection to the present study.

Faunal Consideration

As the Tertiary stratigraphy of the Jôban Coal-field has been studied by many authors and was reviewed by Mr. J. IWAI (1950), the writer devotes this paper to the stratigraphical significance of the smaller Foraminifera of the Honya shale which is distributed from the environs of Taira City at the north to Ena-machi at the south of the Taira-Ena district.

The Honya shale, consisting of mainly bluish-gray or white, thick-bedded shale with incoherent sandstone at the base, contains abundant Foraminifera at Yagawase, just south of Taira City (Lat. 37° 2′ 40″ N., Long. 140° 54′ E.), but few at Kamikuramochi, Kashima-mura (Lat. 36° 59′ 10″ N., Long. 140° 56′ 30″ E.) and at Ena-machi (Lat. 36° 58′ 40″ N., Long. 140° 57′ 30″ E.). The Foraminifera from the boring core drilled into the Honya shale at Yagawase by the Coal Exploration Advancement Committee of Japan was compared with the present material.

The Foraminifera from the Yagawase cores are scattered uniformly throughout the shale, occurring from the depth of 125 meters to the surface (Table 1). This thickness nearly corresponds to the total of the Honya shale at Yagawase.

The foraminiferal fauna from the Honya shale at Yagawase consists of 28 species, of which neritic or bathyal forms as *Bulimina*, *Valvulineria*, *Cassidulina*, *Bolivina*, *Virgulina* and

* Read Sept. 27, 1952; received Sept. 19, 1952.

Table 1. Foraminifera from the Honya shale at Yagawase, Taira City. (Neritic to Bathyal facies)

	Depth of Core-sample 70 m.	125 m.	From the Surface
Anomalina sp.	—	—	R
Bolivina marginata	F	F	F
Bolivina sp.	—	—	R
Bulimina ovata	F	F	A
Cassidulina laevigata carinata	C	C	C
Cibicides cf. *floridanus*	R	—	R
Cyclammina incisa	R	F	C
Dentalina sp.	—	—	R
Elphidium cf. *yumotoense*	—	—	R
Entosolenia hexogona	—	R	R
Epistominella japonica	R	F	F
Eponides umbonatus	F	R	—
Globigerina spp.	F	F	F
Haplophragmoides compressa	F	R	—
Haplophragmoides trullisatum	R	F	F
Lagena striata	—	R	R
Martinottiella communis	R	—	F
Nonion sp.	—	—	R
Nodosaria sp.	—	R	R
Pullenia salisburyi	R	—	F
Quinqueloculina akneriana	—	—	R
Robulus nikobarensis	R	R	R
Rotalia beccarii honyaensis	R	R	F
Sphaeroidina compacta	—	R	R
Spiroplectammina niigataensis	F	F	F
Valvulineria sadonica	R	F	C
Virgulina honyaensis	—	R	F

A: Abundant, C: Common, F: Few, R: Rare

Cyclammina are most common. The fine grained sediments and the absence of carbonaceous material indicate also deposition in the medium-depth zones off the coast.

Foraminifera from Kamikuramochi and Ena (Table 2), on the contrary, consists mainly of shallow water forms, such as *Rotalia* and *Nonion*. The environment of these genera agree with the mega-fossils from these localities which are also of shallow habitat (KAMADA's verbal communication).

Table 2. Foraminifera from the Honya shale at Kashima-mura, Fukushima Prefecture. (Littoral facies)

	Kamikura-mochi	Ena
Bulimina ovata	R	—
Epistominella japonica	R	—
Nonion akitaense	—	R
Nonion japonicum	R	F
Nonionella miocenica	F	F
Quinqueloculina sp.	R	R
Rotalia beccarii honyaensis	A	C

A: Abundant, C: Common, F: Few, R: Rare

Thus, it can be said that the environment of the Honya shale was deeper in the northern part than in the southeastern part.

Age Consideration

The present fauna can be used to correlate the Tertiary formations of the Jôban Coal-field with those of the oilfields of Akita, Yamagata and Niigata Prefectures.

Bolivina marginata, Cassidulina laevigata carinata, Spiroplectammina niigataensis, Nonionella miocenica, Valvulineria sadonica, Bulimina ovata, Robulus nikobarensis and *Cibicides* cf. *floridanus* first appear in the Honya shale and most of them continue upwards into the overlying marine formations, extending their ranges even up to the Kokozura formation (K. ASANO, 1949). Similar stratigraphic occurrences of these species are found from the Funakawa black shale to the overlying Kitaura formation in Akita and Yamagata Prefectures. These Tertiary formations of the oilfields just mentioned are geosynclinal in nature and therefore, characteristic species additional to those above-mentioned occur in association.

The facts presented suggest that the Honya shale may be correlated to the Funakawa formation.

Characteristic species of the Honya shale are also found in the Temblor and Astoria formations in Oregon, Washington and California. Although it is difficult to correlate the present fauna to those of such remote areas, the geological age of the Honya shale may be close to that of the Temblor or Astoria.* This view was first suggested by the evidence of the molluscan fossils (K. KANEHARA, 1937).

Description of New Species

Virgulina honyaensis ASANO, n. sp.

Text-fig. 6

Test elongate, slender, not compressed, both ends rounded, greatest breadth near the middle, earliest part somewhat twisted, later biserial; chambers inflated, increasing gradually in height and length as added; sutures distinct, depressed; wall smooth, finely perforate; aperture elongate, narrow. Length up to 1.2 mm., breadth about 0.3 mm.

Holotype: Institute of Geology and Paleontology, Tôhoku University coll. cat. no. 75290. Yagawase, south of Taira City (Lat. 37° 2′ 40″ N., Long. 140° 54′ E.), Honya shale, Middle Miocene.

Remarks: Differs from both *V. ishikiensis* ASANO and *V. complanata* EGGER by the subcylindrical test which is not tapering. This is only found at the type locality.

Rotalia beccarii honyaensis ASANO, n. subsp.

Text-figs. 11a-c

Test biconvex, dorsal side more convex, periphery broadly rounded, composed of about 4 whorls; chambers inflated, 8 to 10 in last whorl; sutures not limbate, depressed, gently curved, somewhat excavated near umbilicus, which is not clearly granulated; wall

* According to J. A. CUSHMAN and R. E. and K. C. STEWART, from 1848 to about 1918 the Astoria was variously assigned to Eocene, Oligocene and Miocene, but during the past 25 or 30 years the Miocene age has been generally accepted and research has indicated that the Astoria formation belongs in the Middle Miocene.

smooth; aperture a narrow slit at inner margin of apertural face. Diameter up to 1 mm.

Holotype: Institute of Geology and Paleontology, Tôhoku University coll. cat. no. 75291. 1 km. southeast of Kamikuramochi, Kashima-mura, Fukushima Prefecture (Lat. 36° 59′ 10″ N., Long. 140° 56′ 30″ E.), Honya shale. Middle Miocene.

Remarks: Differs from both *R. tochigiensis* UCHIO and *R. yubariensis* ASANO by the characters of the umbilical region on the ventral side of test. This is a common species in the Honya shale of the southeastern part of the Taira-Ena district.

References

ASANO, K., (1949), New Miocene Foraminifera from Japan. *Journ. Paleont., vol. 23*, pp. 423–430, 2 text-figs.

——, (1949), Foraminifera from the Asagai Formation of Fukushima Prefecture, Japan. *Ibid., vol. 23*, pp. 473–478, 2 text-figs.

CUSHMAN, J. A. and PARKER, F. L., (1931), Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California. *Cushman Lab. Foram. Res. Contr., vol. 7*, pp. 1–16, pls. 1–3.

CUSHMAN, J. A. and STEWART, R. E. and K. C., (1947), Five Papers of Foraminifera from the Tertiary of Western Oregon. *Oregon Dept. Geol. Min. Ind., Bull. 36*, pp. 1–110, pls. 1–13.

KLEINPELL, R. M., (1938), Miocene Stratigraphy of California. *Am. Assoc. Petr. Geol.*, pp. 1–450, pls. 1–22.

KANEHARA, K., (1937), Miocene Shells from the Jôban Coal-field. *Bull. Imp. Geol. Surv. Japan, vol. 27*, no. 1, pp. 1–21, pls. 1–5.

IWAI, J., (1950), Kameno-o Formation of the Jôban Coal-field. *Short Papers, Inst. Geol. Pal., Tôhoku Univ., no. 1*, pp. 59–77, 2 text-figs.

RAU, W. W., (1948), Foraminifera from the Miocene Astroria Formation in Southwestern Washington. *Journ. Paleont., vol. 22*, pp. 774–782, pl. 119.

——, (1951), Tertiary Foraminifera from the Willapa River Valley of Southwest Washington. *Ibid., vol. 25*, pp. 417–453, pls. 63–67.

Explanation of Text-figures

Figs. 1, 2. *Spiroplectammina niigataensis* ASANO and INOMATA Yagawase, Taira City. ×30
Figs. 3 a, b. *Robulus nikobarensis* (SCHWAGER) Yagawase, Taira City. ×30
Fig. 4. *Bulimina ovata* D'ORBIGNY Yagawase, Taira City. ×40
Figs. 5 a–c. *Cibicides* cf. *floridanus* (CUSHMAN) Yagawase, Taira City. ×30
Fig. 6. *Virgulina honyaensis* ASANO, n. sp. Yagawase, Taira City. ×40
Fig. 7. *Bolivina marginata* CUSHMAN Yagawase, Taira City ×40
Figs. 8 a, b. *Elphidium* cf. *yumotoense* ASANO Yagawase, Taira City. ×40
Figs. 9 a, b. *Cassidulina laevigata carinata* CUSHMAN Yagawase, Taira City. ×40
Figs. 10 a–c. *Nonionella miocenica* CUSHMAN Yagawase, Taira City. ×30
Figs. 11 a–c. *Rotalia beccarii honyaensis* ASANO, n. subsp. Kamikuramochi, Kashima-mura. ×30


1
3 b
3 a
4
5 c
5 a
5 b
6
8 a
8 b
9 a
7
10 a
10 b
10 c
9 b
11 a
11 b
11 c

PUBLICATIONS RECEIVED (4)

Number

943. Spath, L. F.: A New Tithonian Ammonoid Fauna from Kurdistan Northern Iraq. Bull. Brit. Mus. Nat. Hist., Geol., Vol. 1, No. 4, 1950.
944. Withers, T. H.: Cretaceous and Eocene Peduncles of the Cirripede Euscalpellum. Ibid., Vol. 1, No. 5, 1951.
945. Withers, T. H.: Some Jurassic and Cretaceous Crabs (Prosoponidae). Ibid., Vol. 1, No. 6, 1951.
946. Croft, W. N.: A New Trochiliscus (Charophyta) from the Downtonian of Podolia. Ibid., Vol. 1, No. 7, 1952.
947. Grimsdale, T. F.: Cretaceous and Tertiary Foraminifera from the Middle East. Ibid., Vol. 1, No. 8, 1952.
948. White, E.: Australian Arthrodires. Ibid., Vol. 1, Vo. 9, 1952.
949. 資源研彙報 No. 26, 1952.
950. 東北研究, Vol. 2, No. 3, 1952.
951. Ibid. Vol. 2, No. 4, 1952.
952. Ibid. Vol. 2, No. 5, 1952.
953. Howell, B. F.: Four New Devonian Sponges from Western Australia. Bull. Wagner Free Inst. Sci., Vol. 27, No. 1, 1952.
954. Howell, B. F.: New Lower Cambrian Hyolithes and Brachiopod from Alberta. Ibid., Vol. 27, No. 2, 1952.
955. Howell, B.F.: Calcareous Algae as Index Fossils. Palaeobotanist, Vol. 1.
956. The American Midland Naturalist, Vol. 25, No. 3, 1941.
957. Lonsdale, J. T.: Contributions to Geology, 1944. Univ. Texas Publ. No. 4401, 1945.
958. Macdonald, G. A.: Geology of the Western Sierra Nevada between the Kings and Sanjoaquin Rivers, California. Univ. California Publ. Bull. Dept. Geol. Sci. Vol. 26, No. 2, pp. 215-286, 1941.
959. Downs, T.: A new Mastodont from the Miocene of Oregon with Remarks on *Gomphotherium*. Ibid. Vol. 29, No. 1, pp. 1-20, 1952.
960. Williams, H.: The Great Eruption of Cosequina, Nicaragua, in 1835 with Notes on the Nicaraguan Volcanic Chain. Ibid. Vol. 29, No. 2, pp. 21-46, 1952.
961. Welles, S. P.: A Review of the North American Cretaceous *Elasmosaurus*. Ibid. Vol. 29, No. 3, pp. 47-144, 1952.
962. Whittard, W. F.: Cyclopygid Trilobites from Girvan and a Note on *Bohemilla*. Bull. British Mus. (Natur. Hist.) Geol. Vol. I, No. 10, 1952.
963. Rocznik Polskiego Towarzaystwa Geologicznego, Vol. 21, No. 3, 1952.
964. Navorsinge van die Nasionale Museum. Bd. 1, Stuk 2, 1952.
965. Ma, T. W. H.: Subaerial Frosions and Amounts of Sliding of the Rigid Shell of the Globe in the Pacific Basin Since the End of the Cretaceous. Oceanogr. Sinica.
966. 東亞地質鉱產誌 第二回印刷正誤表 (朝鮮之部), 1953.
967. 東亞地質鉱產誌 第二回印刷正誤表 (滿洲之部), 1953.
968. 東亞地質鉱產誌 第二回印刷正誤表 (支那之部), 1953
969. 九州大学理学部紀要 Ser. D, Vol. III, No. 3, 1952.
970. Ibid. Ser. D, Vol. III, No. 4, 1952.
971. 東北研究 Vol. 2, No. 6, 1952.
972. Ibid. Vol. 3, No. 1, 1953.
973. Ibid. Vol. 3, No. 2, 1953.
974. Gazin, C. L.: The Lower Eocene Knight Formation of Western Wyoming and its Mammalian Faunas. Smithon. Miscell. Coll. Vol. 117, No. 18, 1952

Trans. Proc. Palaeont. Soc. Japan, N. S. No. 11, pp. 61-64, Pl. 6, Sept. 30, 1953

235. NEOGENE ECHINOIDS FROM GIFU PREFECTURE, JAPAN*

AKIRA MORISHITA

Kyoto University

岐阜県産新第三紀の化石海膽類：岐阜県土岐郡端浪町近傍の新第三系より産出した海膽化石 *Echinocyamus crispus* MAZZETTI, *Astriclypeus manni* VERRILL, *Astriclypeus manni minoensis* MORISHITA, *Schizaster* sp. を記載し，夫々の産出層準及び共存化石を明確にする。森 下 晶

Some fossil specimens of echinoids from Mizunami-Machi, Gifu Prefecture are at my disposal. Kazuo HUZITA and Sunao OGOSE have worked out the Tertiary stratigraphy of this district in detail. The following species and subspecies are identified: *Echinocyamus crispus* MAZZETTI, *Astriclypeus manni* VERRILL, *Astriclypeus manni minoensis* MORISHITA and *Schizaster sp.*

Echinocyamus has never been reported from Japan, except a discovery in Ryukyu Islands. *Schizaster* has been discovered in various localities of Japan. Many specimens of this genus from other localities are now under examination. The result will be published in near future. *Astriclypeus* has been known in general to occur in the Miocene rocks of this country.

I wish to acknowledge my indebtedness to Professor Jiro MAKIYAMA of Kyoto University for his kind revision of English and to Mr. Kazuo HUZITA of Ôsaka City University, Mr. Sunao OGOSE of University of Tôkyo and Mr. Junji ITOIGAWA of Kyoto University for their kind offers of the specimens.

Description of Species.

Echinocyamus crispus MAZZETTI

Pl. 6, Figs. 4, 5

1914. *Echinocyamus crispus*, H. L. CLARK: Hawaiian Ech., p. 62

1933. *Echinocyamus crispus*, S. NISIYAMA: Iwanami-Koza, p, 46, figs. 57 A-D

1937. *Fibularia crispa*, JEANNET & MARTIN: Leidsche Geol. Mededeel., VIII, 2, p. 239

1948. *Echinocyamus crispus*, TH. MORTENSEN: Monograph IV 2, p. 185, pl. XLVI, figs. 46, 47, 55

Description—The test is small, pentagonal, and pointed in the anterior ambitus. The abactinal surface is rather flat, and less elevated than in *Fibularia*.

The ambulacral petals are well-developed, with 14 pore-pairs; the pores are round. Each ambulacrum usually reaches to the 2/3 length of radius. The posterior ambulacral petals are somewhat longer than the other three. Each petal gets outside till the 1/4 length of it from the apical system, afterwards parallel, and open at the extremity.

The apical system is subcentral, a little anteriorly. The genital pores and madreporite are indistinct.

The tubercles of abactinal side are rather large.

* Read Sept. 27, 1952; received Oct. 1, 1952.

Measurements :—

(in mm.)	Length	Width
Specimen A	22	15
Specimen B	13.4	7.5

Observation—The material at my disposal consists of two inner moulds of the abactinal side, of which the smaller one is poorly preserved, but the larger one shows considerably distinct ambulacral areas.

These specimens are more or less resembling *Fibularia australis* DESMOULINS, but differ from it in the flattened test, the shorter ambulacra, and the longer posterior paired ambulacra. This species had been discovered in the Ryukyu Limestone of Ryukyu Islands.

Geological Horizon—Oidawara Tuffaceous Mudstone. (Upper Miocene, G)

Locality—Ichihara, Mizunami-Toki-Machi, Toki-Gun, Gifu Prefecture.

Associated Fauna—Macoma tokyoensis MAKIYAMA.

Astriclypeus manni VERRILL

Pl. 6, Fig. 3

1885. *Astriclypeus manni*, L. DÖDERLEIN: *Arch. f. Naturgesch., LI*, 1, p. 35

1900. *Astriclypeus manni*, S. YOSHIWARA: *Zool. Mag., vol. 12*, p. 393, pl. 16, figs. 11, 12

1938. *Astriclypeus manni*, K. ONODA: *Japan. Jour. Zool., vol. 8*, no. 1, p. 8

1939. *Astriclypeus manni*, H. IKEDA: *Jour. Dep. Agr. Kyusyu Imp. Univ., vol. 6*, pls. 2 (8-11), 3 (6-7), 12 (9), 13 (4-6)

1947. *Astriclypeus manni*, I. HAYASAKA: *Acta Geologica Taiwanica, vol. 1*, no. 2, p. 116, pls. 12 (2), 13 (1), 14 (1), 15 (1)

1948. *Astriclypeus manni*, TH. MORTENSEN: *Monograph IV-2*, p. 416, pls. 59, figs. 1-3; 62, fig. 1; 72, figs. 17, 18, 20, 21

1949. *Astriclypeus manni*, A. MORISHITA: *Jour. Geol. Soc. Japan, vol. 55*, p. 256

1952. *Astriclypeus manni*, A. MORISHITA: *Mem. Coll. Sci., Kyoto Univ., ser. B, vol. 20*, no. 2, art, 7, p. 109, table 1, pl. 11, fig. 2

Description—The test is thin, with a sub-pentagonal outline. The apical system is at the centre of test.

The paired ambulacral petals are nearly equal in length and width; the odd one is more or less larger than the other four; all the ambulacral petals are closed at the extremities. The poriferous zone of each ambulacral petals is broad. The lunule situates at the extremity of each ambulacrum.

The actinal surface is flat. The actinal furrows are very distinct.

Observation—Only a complete specimen and several fragments of this species are at hand. This only specimen was compared with *Astriclypeus manni minoensis* in a former paper. (A. MORISHITA, Mem. Coll. Sci., Kyoto Univ., 1952) The other specimens from this district seem to be somewhat larger.

Measurements :—

(in mm.)		
Longitudinal Diameter	118	
Transverse Diameter	129	
Height	14	

Ambulacrum	I	II	III	IV	V
Length of Petal	27	28	29	28	28
Width of Petal	14	13.5	14.5	14	14
Length of Lunule	21	18	16.2	17.5	18
Width of Lunule	7.7	7.7	6.5	7.2	6
Width of Interporiferous Zone	5.7	5	5	5	5
Interval of Petal & Lunule	3.5	3.5	3	3	3

Geological Horizon–Shukunohora Sandstone. (Mid. Miocene, F_2–F_3)

Locality—Shukunohora, Hiyoshi-Mura, Toki-Gun, Gifu Prefecture.

Associated Fauna — Operculina complanata japonica HANZAWA, *Miogypsina kotoi* HANZAWA.

Astriclypeus manni minoensis MORISHITA

Pl. 6, Figs. 1, 2

1952. *Astriclypeus manni minoensis*, A. MORISHITA: *Mem. Coll. Sci., Kyoto Univ., ser. B, vol. 20*, no. 2, art. 7, p. 11, fig. 1

This specimen is same as one of my original description.

Geological Horizon–Shukunohora Sandstone, (Mid. Miocene, F_2–F_3)

Associated Fauna—Same as *Astriclypeus manni.*

Schizaster sp. indet.

Pl. 6, Fig. 6

Description—The test is cordiform in outline and rather low in height. The abactinal surface is elevated to the centre from the ambitus, forming a steep slope in the ambitus. The apical system eccentric posteriorly, situating in 2/5 of the longitudinal diameter. The anterior groove is shallow. All the ambulacra are petaloid and straight, reaching in 2/3 of the radius of test. The posterior paired petals forming an angle of about 70° one another, are very short and about one half of the length of the anterior paired ones. The interambulacrum V is slightly elevated making a keel-like ridge. The peripetalous and lateral fascioles are indistinct.

Measurements :—

(in mm.)		
	Length	39.2
	Width	37.0
	Height	21.8

Observation—As the only one specimen at my disposal shows merely the outline of test and the paired ambulacra, though it appears differing from other forms of the genus, proposal of a new species is postponed.

There are two living species, *Schizaster japonicus*, *Schizaster ventricosus* and two fossil species, *Schizaster recticanalis*, *Schizaster nummuliticus* in Japan. The present form differs from these species in various characters, for instance, differing from *Sch. recticanalis* in the straight postero-lateral ambulacra.

Geological Horizon — Oidawara Tuffaceous Mudstone. (Upper Miocene, G)

Locality — Dan, Mizunami-Toki-Machi, Toki-Gun, Gifu Prefecture.

Associated Fauna—Yoldia laudabilis YOKOYAMA.

References

CLARK, H. L. (1914): Hawaiian Echini, Clypeastridae—Scutellidae.

DÖDERLEIN, L (1885): Seeigel von Japan u. d. Liukiu Inseln. *Arch. f. Naturgesch., LI*, 1.

HAYASAKA, I. (1947): Notes on Some Fossil Echinoids of Taiwan, III. *Acta Geologica Taiwanica, vol. 1*, no. 2.

HUZITA, K. & OGOSE, S (1950): Lithologic Classification of the Cenozoic Strata in the Northern Area of Mizunami-Machi, Toki-Gun, Gifu Prefecture, Japan. *Jour. Geol. Soc. Japan, vol. 56*, no. 662.

IKEDA, H. (1939): Studies on the Pseudofasciole of the Scutellids. *Jour. Dep. Agr. Kyusyu Imp. Univ., vol. 6.*

JEANNET, A. u. MARTIN, R. (1937): Ueber Neozoische Echinoidea aus dem Niederländisch-Indischen Archipel. *Leidsche Geologische Mededeelingen, 8, 2.*

MORISHITA, A. (1949): Neogene Echinoids from Ishikawa and Toyama Prefectures. *Jour. Geol. Soc. Japan, vol. 55.*

——, (1952): Fossil *Astriclypeus* from Japan. *Mem. Coll. Sci., Kyoto Univ., ser. B, vol. 20,* no. 2, art. 7.

MORTENSEN, TH. (1948): A Monograph of the Echinoidea, IV-2 (Clypeastroida).

NISIYAMA, S. (1933): Echinodermata, *Iwanami-Koza* (*Manual of Geology and Palaeontology*).

ONODA, K. (1938): Notes on the Development of Some Japanese Echinoids. *Japan. Jour. Zool., vol. 8,* no. 1.

YOSHIWARA, S. (1900): Japanese Echini. *Zool. Mag., vol. 12.*

Explanation of Plate 6

Fig. 1. *Astriclypeus manni minoensis* MORISHITA, in Shukunohora Sandstone. Abactinal Side. ×3/5

Fig. 2. *Astriclypeus manni minoensis* MORISHITA, in Shukunohora Sandstone. Abactinal Side. ×1/2

Fig. 3. *Astriclypeus manni* VERRILL, in Shukunohora Sandstone. Abactinal Side. ×3/5

Fig. 4. *Echinocyamus crispus* MAZZETTI, in Oidawara Tuffaceous Mudstone. Abactinal Inner Mould. Nat. Size.

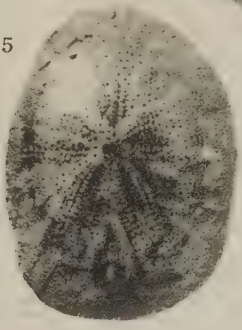
Fig. 5. *Echinocyamus crispus* MAZZETTI. Same Specimen as Fig. 4. ×2.

Fig. 6. *Schizaster* sp., in Oidawara Tuffaceous Mudstone. Abactinal Side. ×3/4

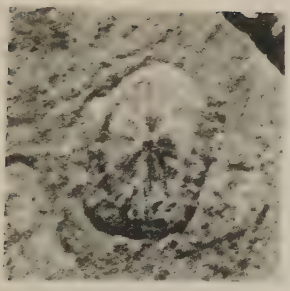
1

2

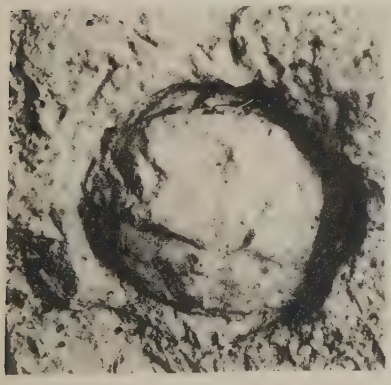
5



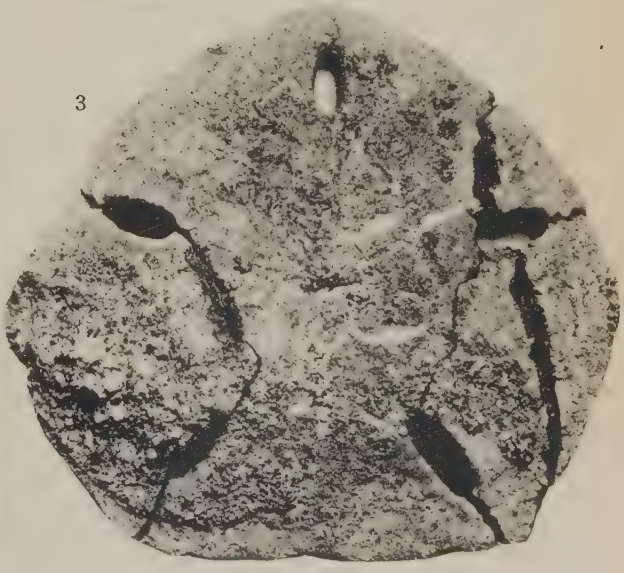
4



6



3



Trans. Proc. Palaeont. Soc. Japan, N. S. No. 11, pp. 65—73, 3 text-figs., Sept. 30, 1953

236. ON SOME RETICULATE SPIRIFERIDAE*

MASAO MINATO

Department of Geology and Mineralogy, Faculty of Science, Hokkaido University.
Sapporo, Japan.

亞科 Reticularinae WAAGEN の腕足類につき，単列型の棘基を有するものと，両列型の棘基を有するのとに 2 大別し，さらに殻頂構造の差異によつて属を識別した。 *Georgethyris*, *Sinothyris*, *Martinothyris*, *Condrathyris*, *Nebenothyris* の諸属を新しく提唱した。湊 正 雄

Squamularia GEMMELLARO 1899; *Reticularia* M'COY 1844; *Georgethyris* nov. *Sinothyris* nov.; *Phricodothyris* GEORGE 1932; *Martinothyris* nov.; *Torynifer* HALL and CLARKE 1895; *Kitakamithyris* MINATO 1951; *Spirelytha* FREDERICKS 1919; *Condrathyris* nov.; and *Nebenothyris* nov. are treated in this note.

There are two groups in the subfamily Reticularinae WAAGEN in respect to the nature of spine bases which ornament shell surface; one group with uniramous spine bases, the other with biramous. Several genera are also distinguished in each of these groups based upon the apical strucuture of shells. Thus the following classification of this subfamily is now presented.

I) With uniramous spine bases.

Without apical plates except delthyrial ridges .....*Squamularia* GEMMELLARO, 1899; Permian

With parallel dental plates and median septum ..... *Reticularia* M'COY, 1844; Lower Carboniferous

With divergent dental plates .....*Georgethyris* MINATO, nov.; Lower Carboniferous

With median septum in ventral valve but lacking other plates .....*Sinothyris* MINATO, nov.; Devonian

II) With biramous spine bases.

Without dental plates and median septum... .....*Phricodothyris* GEORGE, 1932; Lower Carboniferous to Permian

With dental plates in ventral and socket plates in dorsal valve.....*Martinothyris* MINATO, nov.: Lower Carboniferous

With median septum in each valve.....*Nebenothyris* MINATO, nov.; Lower Carboniferous to Permian

With dental plates and median septum in ventral valve and median septum in the dorsal valve.....*Torynifer* CLARKE and HALL, 1895; Lower Carboniferous

With dental plates and mediam septum in ventral valve but without an apical plates in dorsal valve.....*Kitakamithyris* MINATO, 1951; Lower Carboniferous

With pseudospondylium .....*Spirelytha* FREDERICKS, 1919; Permian

With any apical plates in ventral valve but with socket plates in dorsal valve ..... *Condrathyris* MINATO, nov.; Middle Carboniferous

I) Group with uniramous spine bases

Genus *Squamularia* GEMMELLARO, 1899

No dental plates and no median septum but with delthyrial ridges.

Genolectotype: *Squamularia rotundata* GEMMELLARO, 1899

Genus *Reticularia* M'COY, 1844

There are three species which have been regarded as genotypes of this

* Read Dec. 12, 1951; received Nov. 6, 1952.

genus, which are *Anomites lineata*, *Terebratula imbricata* and *Reticularia reticulata*. According to GEORGE,[1] BUCKMANN considered that *Reticularia reticulata*, of which the specific name has the same meaning as the generic, must become automatically the genotype by the Rules of Nomenclature. However "reticulata" is said to be not literally the same word of "Reticularia" and the original specimen of *R. reticulata* M'COY, according to GEORGE, was lost, so we are at present unable to clarify the specific distinction of this genus from amongst the original syntypes of M'COY; therefore *Reticularia reticulata* should not be used as a genotype, until such time as the holotype be found. Then the priority of designation become the next problem. The matter is quite important, because these two types of "lineata" and "imbricata" are not congeneric, as will be stated. According to GEORGE, *Anomites lineata* has quite well developed dental plates, but no median septum, while *Terebratula imbricata* has median septum besides the dental plates; moreover, he mentioned that plates of the latter are parallel in arrangement toward the floor of the shell, instead of divergent as in the former. WAAGEN, FREDERICKS and others supposed *Anomites lineata* to be a genotype of the genus *Reticularia*.

However DAVIDSON was the first, so far as the writer has been able to find, who designated unequivocally *Terebratula imbricata* SOWERBY as the type of *Reticularia*, instead of *Anomites lineata* M'COY. The same view had also been stated by GEORGE formerly.

Thus the genotype is determined: the original description of M'COY well corresponds to the features of specimens designated by GEORGE as *Reticularia imbricata*.

The original description of M'COY runs as follows:

"General character: Hinge line shorter than the width of the shell; cardinal at a triangular; cardinal angles very obtusely rounded; mesial fold very slightly raised or none; surface ornamented with either fine longitudinal or transverse striae, or most usually reticulated by both; dental lamellae perfectly parallel."

"This beautiful little group includes all those spirifers analogous to *S. imbricata*, *S. lineata*, *S. microgemma*, *S. reticulata*, *S. decussata*, etc. having a reticulated or striated surface combined with the general form and cardinal area of *Martinia* M'COY, in which genus I formerly placed them, although they obviously formed a very marked group, distinguishable by its small size, reticulated or striated surface, and very remarkably by the entire absence of the mesial fold in most species (in one or two species which possess a trace of mesial fold, it is very slightly elevated). But the internal structure which I have recently seen in three of the species presents a very distinct and important character; the dental lamellae, instead of converging towards the beak (@ that is, having diverge plates towards the floor of the shell) as in all other forms of *Spirifer*, are in those specimens perfectly parallel to each other and to the central septum, in their whole length. The genus is Carboniferous and Devonian."

Thus M'COY laid special stress on the possession of dental plates, which are divergent towards the floor of the shell, to distinguish his newly established genus, from allied genera. However GEORGE considered later on that the importance of M'COY's statement rests only in its recognition of the development of dental plates, rather than in

---

1) GEORGE T. N.: The British Carboniferous Reticulate Spiriferidae. *Q J.G.S. London, vol. 88* p. 516, 1932.

@) by the writer.

the manner of their arrangement as either parallel or divergent. The present writer wishes to emphasize the importance of M'Coy's diagnostic statement regarding the manner of the development of dental plates.

The next problem is the surface ornamentation of shell, especially in the spine base of the genotype. George formerly regarded to be important the shell surface of the genus *Reticularia* with uniramous spines, instead of biramous ones, though he was not entirely certain about it.

George described the spine bases of the genus *Reticularia* as follows: "*Some of the nodes are divided by a feeble median furrow, and then distantly suggest the split spine-bases of species of Phricodothyris.*"

This description may indicate, in the writer's opinion, somewhat biramous nature of the spines. Notwithstanding this, George also offered some remarks in the description of *Reticularia profecta*[1] that these types of spine bases are quite distinct from the definite biramous spines of *Phricodothyris*. His statement runs as follows: "*The ornament is well preserved on part of the shell. The concentric lamellae occur about 6 to 8 in a length of 10 mm. What appear to be bases of split spines are well displayed on each lamella. These are by no means comparable with the biramous spine-bases of species of Phricodothyris, but are very similar to those occurring on Reticularia imbricata: that is, though divided posteriorly, the two elements appear to fuse along the anterior border of the lamellae. There are about 15 of such spine bases in a width of 10 mm.*"

Therefore the spines of the genotype of the genus *Reticularia* may be different from either the usual biramous or from the uniramous type, but they may be grouped rather in the category of the latter type from George's observation; the writer wishes here follow his view.

Thus the diagnostic character of the genus *Reticularia* may be summarized as follows: brachythrid shell in form, biconvex, hinge line shorter than the greatest width, provided with dental plates and median septum; the former two arranging in parallel but neither divergent nor convergent toward the floor of the ventral valve. The whole surface is covered by concentric lamellae with pustules which may possibly be uniramous.

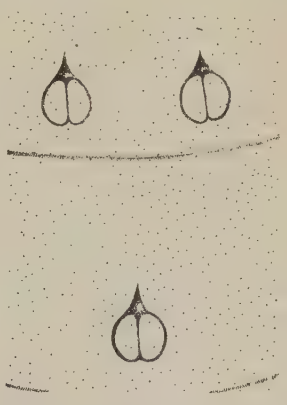


Fig. 1. Showing the spine bases on the shell surface of *Kitakamithyris hikoroitiensis* (Minato). Ca 12 times enlarged.

Genotype: *Reticularia imbricata* (M'Coy) 1844

Reticularia mesolobe (Phillips) may belong to the same category of the genotype of *Reticularia* in possession of dental plates in parallel, although its surface ornamentation, is not at all known to me at present. Other reticuloid shells as George designated in the genus *Reticularia* may have

1) George T N.: *Q.J.G.S. vol. 88*, p. 565.

uniramous spine bases. The dental plates of some species among them show slight divergence toward the floor of the ventral valve, especially at the apex of the valve. Moreover some species, such as *R. alexandri*, lacks median septum and bears dental plates divergent at an angle of about 20°. Such being the case, they may be more precisely subdivisible in the generic rank, and may hold each its own phylogenetic position regarding the development or arrangement of the dental plates as well as median septum.

Here the writer proposes to separate *R. alexandri* from the genus *Reticularia*, and wishes to establish for it a new genus *Georgethyris* MINATO.

Genus *Georgethyris* MINATO, nov.

Genotype: *Reticularia alexandri* GEORGE, 1932

The internal structure of this genus is quite the same as that of genus *Eoreticularia* but in the surface ornamentation they are different from each other, the latter being quite deficient in every respect.

Genus *Sinothyris* MINATO, nov.

Without dental plates but with median septum in the ventral valve.

Genotype: *Reticularia maurrei* (HOLZAPFEL)[1]

The surface ornamentation of the shells at this species coincides well with the usual reticulate spirifers but it is without dental plates. Only the existence of median septum is indicated.

There are also rather strong radiating vascular grooves represented by faint ridges in the internal mold.

II) Group with biramous spine bases

Genus *Phricodothyris* GEORGE, 1932

The original definition by GEORGE runs as follows:

"Brachythyrid, relatively brephomorphic, primitive in shell form. Spiralia directed more or less laterally: jugum or jugal processes apparently absent. Surface-ornament of biramous spines. Shell-structure fibrous, impunctate. Internal plates usually absent, but progressive, frequently attaining primary, and sometimes the basilary stage, but never the intermediate stage."

Genotype: *Phricodothyris lucerna* GEORGE, 1932

Thus GEORGE[2] defined and included in his newly established genus such species as *P. ericius*, *P. lineata*, *P. insolita*, *P. lucerna*, *P. paricosta*, *P. periculosa* and *P. verecunda*. Among them he offers no observation on *P. insolita* regarding the internal structure which should have further investigation. Other species except *P. lineata* lack, according to his observation, either dental plates or median septum. Only the so-called "*Phricodothyris lineata*" (MARTIN) of GEORGE has dental plates of ventral valve as well as socket plates of dorsal valve, though it is devoid of median septum. This species should be regarded, in the writer's opinion, as not congeneric with other species of the genus *Phricodothyris*. Therefore the definition of this genus should be corrected as follows: *with no apical plates in both valves, except the delthyrial ridges.*

1) GRABAU, A. W.: Devonian Brachiopoda of China, *Palaeontologia Sinica, Ser. B, vol. 3, Fasc. 3*, p. 394, Pl. XLIm figs. 2-7, 1931.

2) GEORGE, T. N.: The British Carboniferous Reticulate Spiriferidae, *Q.J.G.S. London, vol. 88*, p. 516, 1932.

In this respect, genus *Squamularia* is quite the same as *Phricodothyris* and the distinguishing criteria of these two genera are only in the nature of the spine bases; the former of which is uniramous in contrast to the biramous character of the latter. Although the shell ornament was said to be not originally precisely examined in the case of the genotype of *Squamularia*, the later investigators clarified this point. That is that the spine bases of this genus *Squamularia* are definitely uniramous.

DEMANET[1] who believed the validity of this genus *Phricodothyris* added such three species as *P. tripustulosa*, *P. monopustulosa*, and *P. georgei* which came from the passage bed of the Dinantin to the Namurian in Belgium. All species described by both GEORGE and DEMANET may belong to the higher Lower Carboniferous in Western Europe, while this genus may be seen to range until a much later time in Eastern Asia, because *Squamularia echinata* described by CHAO[2] from the Taiyuan Series of North China is nothing but *Phricodothyris*, which bears a distinct double barrelled type of spines but possesses neither dental plates nor median septum.

Phricodothyris is also found newly from the Japanese Permian.

Of the so-called *Reticularia lineata* of the Salt Range, described by WAAGEN,[3] the internal structures are unfortunately unknown, although the spine bases, according to DAVIDSON, are of distinctly biramous type. In *Reticularia indica* WAAGEN,[4] there are no median septum and no dental plates, so it may probably belong to the same category as *Phricodothyris*, though WAAGEN did not describe definitely the nature of the spine bases.

Reticularia elegantula WAAGEN,[5] found in association with the last one from the Salt Range also bears biramous spines, while the internal structures of the pedicle valve were not investigated by him.

Genus *Condrathyris* MINATO, nov.

With no dental plates and no median septum in the ventral valve but provides distinct socket plates in the dorsal valve.

Genotype: *Squamularia ? perplex* (McCHESNEY) of DUNBAR and CONDRA

DUNBAR and CONDRA[6] hesitated to assign their species to the genus *Squamularia*. This species has biramous spines on the shell surface and lacks dental plates as well as median septum in the ventral valve, therefore it should be regarded to belong to the genus *Phricodothyris* rather than to *Squamularia*.

However they pointed out the presence of a pair of lamellae in the dorsal valve, which they considered as serving as the supports of the crual plates. These are the present writer's socket plates. And the socket plates of this species are not parallel to the floor of the dorsal valve, but arranged in convergency. The writer supposes that this species may not be conspecific with the species reported under

1) DEMANET, F.: La Faune des Couches de passage du Dinantien au Namurien dans le synclinorium Denant. *Mem. Muse Royal. d'Hist. Nat. belg. Mem. no. 84*, p. 94, 1938.

2) CHAO, Y. T.: Carboniferous and Permian Spirifers of China. *Pal. Sinica, Ser. B, vol. XI, fasc. 1.* p. 86, pl. VIII, fiig. 19, 1929.

3) WAAGEN, W.: Salt Range fossils. *Palaeontologia Indica, Ser. XIII*, 1882, p. 540, pl. XLII, figs. 6–8.

4) WAAGEN, W.: op. cit. p. 542, pl. XLIII, fig. 2.

5) WAAGEN, W.: op. cit. p. 545, pl. XLIV, fig. 1.

6) DUNBAR, C. O. and CONDRA, G. E.: Brachiopoda of the Pennsylvanian system in Nebraska. *Nebraska Geol. Surv. Bull. 5*, p. 313, pl. XLII, figs. 5–8, 1932.

the same name by GIRTY[1] from the Wewoka formation of Oklahoma. GIRTY mentioned that there are no internal plates in his species. The writer wishes here to establish a new genus based upon DUNBAR and CONDRA's specimens.

This came, according to them, from the Middle Pennsylvanian in Nebraska.

Genus *Martinothyris* MINATO, nov.

With dental plates in the ventral valve, with socket plates and incipient median septum in the dorsal valve.

Genotype: *Phricodothyris lineata* (MARTIN), 1932 @ of GEORGE

According to GEORGE,[2] the type of "*Reticularia lineata*" was lost and he selected as neotype a specimen from the type locality, where MARTIN recorded the species as being particularly common. This agrees, in his opinion, with the specimens in MARTIN's figure in proportions and general appearances. Diagnosis of this species stated by him was as follows: "*A transverse species of Phricodothyris, typically rectimarginate, the anterior margin being semicircular in dorsal view. Apical plates variously developed between primitive and intermediate stages.*

Thus GEORGE[3] did not recognize the prime importance to distinguish the shells either specifically or generically in respect to the presence or absence of the apical plates of the valves.

He regarded all specimens with or without apical plates in one genus. But the present writer cannot agree with that view.

Of GEORGE's specimens, the one illustrated by him on page 546 under the name *Phricodothyris lineata* is devoid of any apical plates and therefore that specimen is nothing but a *Phricodothyris*.

But the specimen on page 545 has dental plates in the ventral valve and two socket plates in the dorsal valve. The writer selects this specimen as the genotype and wishes to propose a new genus. In this new genus, dental plates are sub-parallel in arrangement, which is quite worthy of note, and, moreover, a short median septum is present, which is quite incipiently indicated in the dorsal valve.

Thus the apical apparatus of this genus is quite the same as that of the genus *Martinopsis*, except for the presence of a short median septum in the dorsal valve.

Genus *Torynifer* HALL and CLARKE, 1895

The exterior of the shell is ornamented by concentric lamellae and biramous spines like *Phricodothyris*, but this genus provides always strong dental plates and median septum in the ventral valve, and, besides this, it bears distinct median septum in the dorsal valve.

The Mississippian species described by WELLER[4] under the names of *Reticularia pseudolineata*, *R. setiger* and *R. cooperensis* are assignable to this genus. M. A. STAINBROOK[5] described

1) GIRTY, G. H.: Fauna of the Wewoka formation of Oklahoma. *U. S. G. S. Bull. no. 544*, 1915, p. 92, pl. XI, figs. 1-3a.

@) *Phricodothyris lineata*, p. 545, fig. 6, GEORGE, op. cit.

2) GEORGE, T. N.: The British Carboniferous Reticulate Spiriferidae. *Q. J. G. S. London. vol. 88*, p. 543.

3) Ibid., p. 555.

4) WELLER, S.: The Mississippian Brachiopoda of the Mississippi valley basin. *Monograph 1. State Geol. Surv. Illinois*, p. 437, 1914.

5) STAINBROOK, M. A.: Brachiopoda of the Percha Shale of New Mexico and Arizona. *Jour. Paleont. vol. 21, no. 4*, 1947, p. 325, pl. 47, figs. 38-42.

one species of this genus from the Lowest Member of the Mississippian in New Mexico.

Genotype: *Torynifer criticus* HALL and CLARKE

Genus *Kitakamithyris* MINATO, 1952

With dental plates and a median septum in the ventral valve but no septate partitions in the dorsal valve.

Genotype: *Torynifer* (*Kitakamithyris*) *tyoanjiensis* MINATO.

A few species of this group from the Lower Carbiniferous of Japan may be quite like genus *Torynifer* in the outer configuration of shells, external ornamentation and internal structures of the ventral valve, but they differ from the latter in possessing no median septum in the dorsal valve.

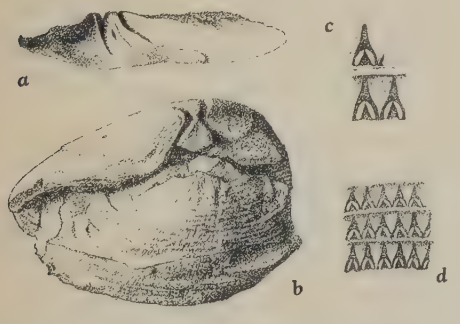


Fig. 2. *Kitakamithyris tyoanjiensis* (MINATO)
a: showing traces of dental plates and median septum in the ventral valve. ×1
b: dorsal view of shells. ×1
c: spine bases, enlarged 10 times.
d: spine bases, enlarged 5 times.

All species mentioned by HALL and CLARKE as members of the "Lamellosi dupliciplicati" may belong to the genus *Torynifer* except the Hamilton species. The so-called *Spirifer fimbriatus* CONRAD of HALL and CLARKE bears radial plications and may be rather regarded as allied with *Plectospirifer* than with *Reticularia*. But it bears biramous spines and must be not wholy congeneric with either of them. This species comes from the Devonian Hamilton Formation and the other species under the group of lamellosi dupliciplicati may come from the Mississippian and younger formations.

Thus such reticulate spirifers with biramous spines and dental plates as well as a median septum in the ventral valves as *Torynifer* and *Kitakamithyris* began to appear from the Lower Carboniferous but not from the Devonian in age.

Genus *Spirelytha* FREDERICKS, 1919

With pseudospondylium.

Genotype: *Spirifer schei* TSCHERNYSCHEW 1916 @

According to GEORGE,[2] this genus from the arctic Permian is provided with biramous spines and pseudospondylium. According to PAECKELMANN[3] there is an incipient median septum in this genus.

1) MINATO, M.: On the Lower Carboniferous fossils of the Kitakami massif, northeast Honsyu, Japan. *Jour. Fac. Science, Hokkaido Univ., Ser. IV, Geol. and Min. vol. VII, no. 4*, p. 374, 1951.
MINATO, M.: A. further note on the Lower Carboniferous fossils of the Kitakami Mountainland, Northeast Japan. *Ibid, vol. VIII, no. 2*, p. 170, 1952.

2) GEORGE, T. N.: The British Carboniferous Reticulate Spiriferidae. *Q. J. G. S. London, vol. 88*, p. 525, 1932.

3) PAECKELMANN, W.: Versuch einer zusammenfassenden Systematik der Spiriferidae KING. *N. Jb. f. Min. usw. Beil. Bd. 67, Abt. B*, 1932.

@) FREDERICKS, G.: *Bull. Geol. Com., vol. 38, no. 3*, 1919, p. 304.

Genus *Nebenothyris* MINATO, nov.

Genotype: *Spirifer (Reticularia) lineatus* NEBE, @@ non MARTIN

The species described and figured by NEBE from the Culm formations of Haagen under the name of *Spirifer (Reticularia) lineatus* (MARTIN) has a prominent median septum in the ventral valve and moreover has such a septum in the dorsal valve.

There is no other apical plate in this specimen. Basing his opinion upon such peculiarity in the septated partions of the apicals, the writer wishes to propose a new generic name for this species.

NEBE described as follows: "*Auffalend ist eine schmale, aber scharfe Medianlesiste der Stielklappe, die aber auch in der Armklappe angedeutet ist.*" Next the problem arises, whether this species is ornamented by the uniramous spines or by biramous ones, because NEBE mentioned nothing about it. However NEBE regarded his species as being quite conspecific with the species described by SCUPIN[1] in his monograph under the name of *Reticularia lineata*. Meanwhile SCUPIN's specimens were said to be provided with distinct biramous spines. Therefore the diagnostic character of this genus may be summarized as: With median septa in the ventral as well as dorsal valves. Ornamented by concentric lamellae and biramous spines.

One species described and figured by REED[2] from the Paleozoic of Yunnan, S. China, under the name of *Reticularia sublineata* REED, is specially worthy of note. It is ornamented with biramous spines on the whole surface of the shell with concentric lamellae, and possesses no dental plates, except divergent teeth in the ventral valve. But there is a prominent median septum in the ventral valve in this species. Besides this, the existence of one more septum in the dorsal valve is indicated by his illustration, though he did not mention such a structure.

The feature of the special plates of this species may accordingly be quite common with the genotype of this new genus just proposed above. However REED did not offer any remarks on the existence of such a septum in the dorsal valve, as above stated, and the writer is very hesitant to consider this species as being wholy congeneric with *Nebenothyris*. If the median septum is lacking in the dorsal valve, REED's species should be separated in subgeneric rank from *Nebenothyris*. REED's description about his species runs as follows:

"Shell subcircular, gently biconvex. Pedicle-valve moderately convex, not inflated, with a narrow weak median groove extending from the beak to the anterior margin, but no sinus. Beak strongly incurved, and umbonal slopes rounded. Interior of valve with short small divergent teeth, but no dental plates: broad low ridge running forwards from apex of beak nearly to front margin, narrowing and decreasing in strength anteriorly, subangular and prominent between the narrow flabelliform ill-defined didductor scars. Whole of rest of interior (including muscule-scars) marked with fine radiating closely placed striae, somewhat sinuous and broken on inosculating in some places and occasionally deeping into pits.

@@) NEBE, B.: Culmfauna von Haagen, ein Beitrag zur Kenntnis des westfallishes Unterkarbons. *N. Jb. f. Min. usw. Beil. Bd. 31*, p. 44, pl. 14, fig. 14, 1911.

1) SCUPIN, J.: Spiriferen Deutschlands. p. 52, pl. 4, figs. 11-13, 1900.

2) REED, C.: Palaeozoic and Mesozoic fossils from Yun-nan. *Palaeontologia Indica. New Series. vol. X, mem. no. 1.* 1929, p. 146, pl. XIV, figs. 3-6.

"External surface of shell covered with thin broad concentric laminae of subequal width, each bearing a submarginal single row of "double-barrelled" hollow spine-bases of laterally compressed oval or subcircular form, the "barrels" being longitudinally oval and lying side by side: small low sharp tubercles and spinules lie between and in front of each row of spine-bases on the laminae (leaving punctate on the internal cast)."

In concluding the writer is much indebted to Prof. I. HAYASAKA for his kind reading manuscript and criticism given by him during the course of this study.

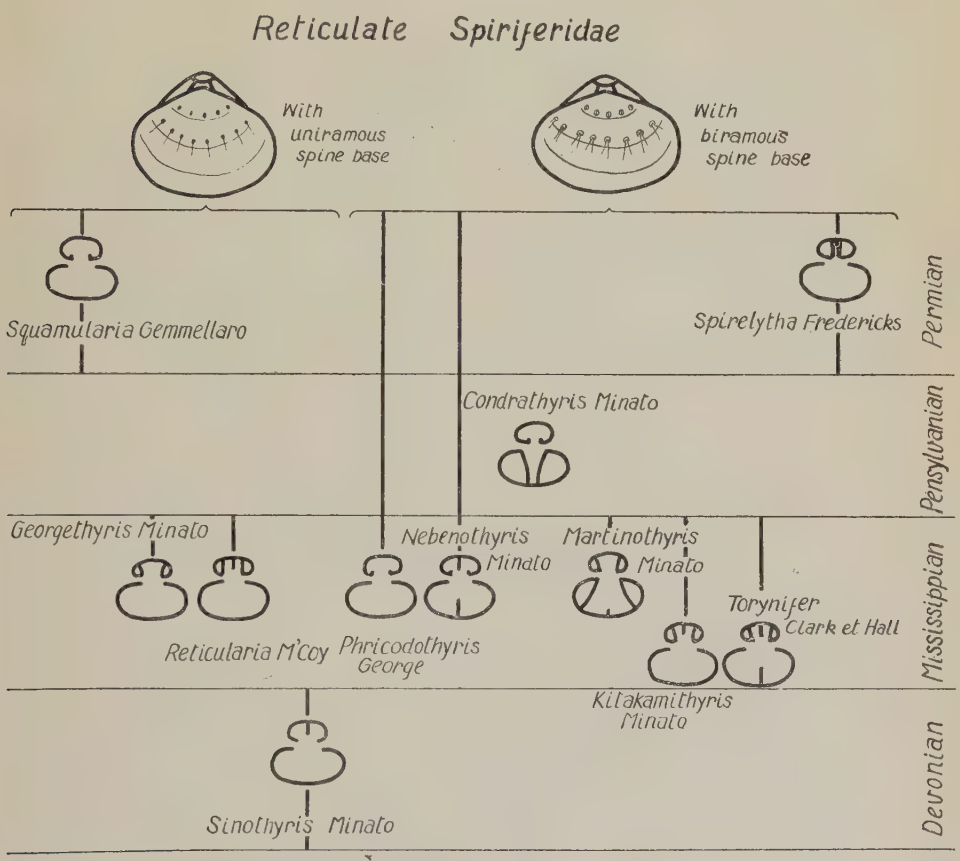


Fig. 3. Showing the geological distribution of some reticulate spirifers, and apical structures of each genus. Above: ventral valve, below: dorsal valve, with or without dental plates, socket plates, median septum or pseudospondylium.

ERRATA

to Article 231, N. S. No. 10, pp 31—36 (KOTAKA)

Page	Column	Line	Read	for
31	right	12	*bisenensis*	*bisenenesis*
32	〃	19	Φ_{22}	Φ_{11}
〃	〃	21	Φ_{11}	Φ_{22}
〃	〃	14 from below	freedom	reedom
34	Table 1	No. 9	Taitô	Taito
〃	〃	No. 10	Byôbugaura	Byobugaura
〃	〃	No. 13	Yûrakuchô	Yurakucho
〃	below Table 1		θ: Inclination... / a: Length ..... / b: Length ... } of ...	θ: Inclination .. / a: Length ..... / b: Length ..... } .. of
35	right	8	Figs. 1a-d, 2a-d, 6a-c.	Figs. 1a-6c.
〃	(Measurement) Convexity	4 from below	48.9	48.6
〃	C / L	1 from below	21.75	21.73

---

to Article 232, N. S. No. 10, pp. 37—44 (HAYASAKA and HAYASAKA)

Page	Column	Line		Read	for
37	right	13	:	author	auther
38	〃	5		genera	general
〃	〃	22	:	the	thc
40	〃	13	:	referred	refer
〃	〃	21, 25			
41	〃	11			
42	〃	22, 23, 30, 34	—:	MacGinitie	MacGinite
44	left	bottom			
41	r	15 from below	:	was	we
42	〃	14 from below	:	*Schizothaerus*	*Schizohaerus*
43	l	21	:	in	is
〃	r	bottom	:	an	on

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 11, pp. 75—82, Pl. 7, 3 text-figs., Sept. 30, 1953

237. ON THE *PECTEN NOTOENSIS* YOKOYAMA*

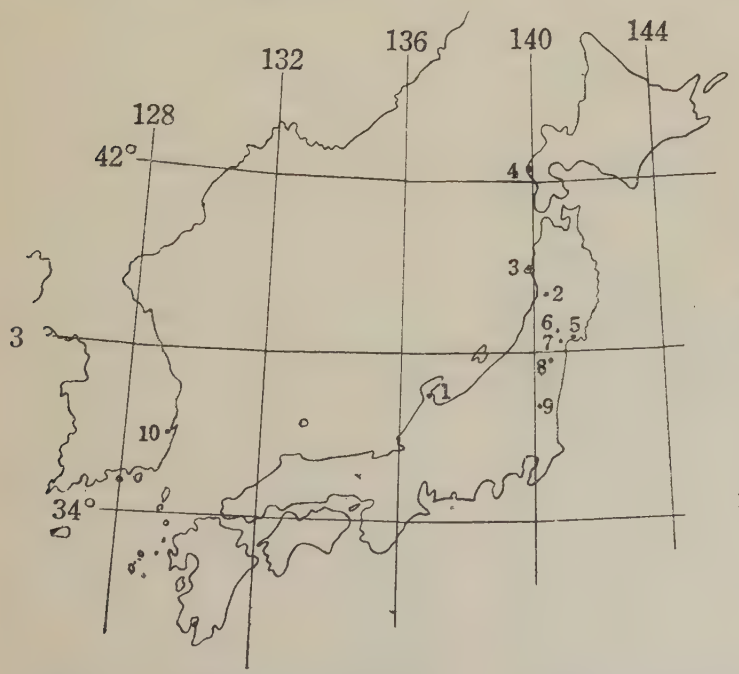
(On the Miocene Pectinidae from the Environs of Sendai, Part 2)

KOTORA HATAI and KÔICHIRÔ MASUDA

Department of Geology, College of Education, Tôhoku University.

Pecten notoensis YOKOYAMA に就いて：（仙台附近中新統産 Pectinidae. その 2）
Pecten notoensis YOKOYAMA の形態を研究し，新に *Nanaochlamys* なる新属を提唱した。更にこれの地質学的意義に関する考察を行つた。畑井小虎・増田孝一郎

Among the Pectinidae fossils hitherto described from the Neogene of Japan, *Pecten notoensis* YOKOYAMA is of particular interest because of its peculiar sculpture, restricted geological range and limited geographical distribution (Text-fig. 1). The occurrence of *notoensis* in formations of more or less similar lithology and with a closely related associated fauna serve as important data in analysing its paleoecological conditions. These problems are dealt with in this article.



Text-fig. 1. Map showing the distribution of *Nanaochlamys notoensis* (YOKOYAMA).

* Read Sept. 27, 1952; received Nov. 21, 1952.

Pecten notoensis, first described by M. YOKOYAMA (1929) from a richly calcareous sandstone at Iwaya about 700 meters west of the Nanao railway Station, Nanao City in Ishikawa Prefecture, was referred to the genus *Chlamys* by Y. ÔTUKA in 1933, who studied the geology of the district, thereby including the sandstone into his Nanao formation, which he called Miocene. This sandstone contains besides *Pecten notoensis*, abundant specimens of other pectinids, brachiopods, bryozoans, sponge spicules, foraminifers and rarely Shark's teeth.

In 1930, H. MATSUMOTO described as new to science from the Miocene Moniwa formation in the southern border of Sendai, *Pecten natoriensis*, *P. natoriensis* var. *subovalis*, and, *P. natoriensis* var. *inequilateralis*. These varieties as well as the species were included into the synonymy of *Pecten notoensis* by S. NOMURA in 1940, a procedure which has been accepted by subsequent authors. These different variety names serve to demonstrate the variability of *Pecten notoensis*. In the southern border of Sendai, *notoensis* occurs abundantly in a calcareous, granule conglomerate to coarse grained sandstone in association with abundant pectinids, pelecypods, brachiopods, bryozoans, echinoids and balanids. Shark's teeth occur rarely.

About one hundred specimens of *Pecten notoensis*, now in the collections of the Institute of Geology and Paleontology and of the Department of Geology in the College of Education, both of the Tôhoku University, and also the Saitô Hô-on Kai Museum, all in Sendai, were studied, and the result of examination is presented herein. We thank Mr. K. ÔYAMA of the Geological Survey of Japan, for his kind loan of an important article.

Family Pectinidae

Subfamily Pectininae

Genus *Nanaochlamys* HATAI and MASUDA, n. gen.

Genotype: — *Pecten notoensis* YOKOYAMA, 1929.

Type locality: — Calcareous sandstone of the Miocene Nanao formation at Iwaya, Nanao City, Ishikawa Prefecture.

Geological range: — Early Miocene.

Diagnosis: — Equilateral, subequivalve, suborbicular, thick-shelled, moderately inflated; five to six, smooth or rarely nodulose ribs, which bifurcate at or near anterior margin and carry several intercalary threads. Auricles unequal, the anterior larger and with strong radial threads and fine concentric lines, the posterior with radial threads and fine concentric lines. Byssal notch conspicuous. Ctenolium rarely ill-developed. Valves unequally convex, the maximum points of convexity situated at different distances from the beak.

Remarks: — *Pecten notoensis* has been referred to the genus *Chlamys* because of its *Chlamys*-like aspect, but it is distinguished from that genus by the well developed byssal notch and ctenolium, pronounced imbricated surface, and by the surface of the valves being similarly sculptured with radial ribs. This new genus resembles *Mesopeplum* IREDALE (IREDALE 1929, pp. 162–164), from the depth of 40–80 fathoms off New South Wales, Eastern Australia. The latter, however, has five prominent, distant, compound ribs, with the intervals broader than the ribs, three riblets on the back of the ribs and four to eight, fine riblets in the interspaces between the ribs on the left

valve; similarly the right valve has five compound ribs whose intervals are narrower than broad, and bear four to eight riblets on their back and two or three riblets in the interspaces; and the byssal notch is minute and hardly noticeable. Therefore, the latter is easily distinguished from the former by the characters of the ribs, difference in sculpture of the right and left valves and by the conspicuous byssal notch. The genus *Scaeochlamys* (IREDALE 1929, pp. 162–163) resembles *Nanaochlamys* in having discrepant sculpture of the right and left valves, but is distinguishable from the latter by the pronounced byssal notch and pectinidial teeth, few prominent scaly ribs on the left valve and numerous less scaled ribs on the right valve.

Nanaochlamys notoensis (YOKOYAMA), 1929

Pl. 7, Figs. 1–7, Text-figs. 2-3.

1929. *Pecten notoensis* YOKOYAMA, *Imp. Geol. Surv. Japan. Rep. No. 104*, p. 4, pl. 3, figs. 1, 2, 3, 4; pl. 4, figs. 1, 2; pl. 5, figs. 1, 2.

1930. *Pecten natoriensis* MATSUMOTO, *Sci. Rep. Tôhoku Imp. Univ., Ser. 2, vol. 13*, no. 3, p. 104, pl. 40, figs. 10, 11.

1930. *Pecten natoriensis subovalis* MATSUMOTO, *Sci, Rep. Tôhoku Imp Univ., Ser. 2, vol. 13*, no. 3, p. 105, pl. 40, fig. 12.

1930. *Pecten natoriensis inequilateralis* MATSUMOTO, *Sci. Rep. Tôhoku Imp. Univ., Ser. 2, vol. 13*, no. 3, p. 105, pl. 40, figs. 13, 14.

1935. *Pecten* (*Pecten*) *notoensis* YOKOYAMA, NOMURA & ZINBO, *Saito Ho-on Kai Mus., Res. Bull., no. 6*, p. 161, pl. 15, fig. 27.

1940. *Pecten* (*Chlamys*) *notoensis* YOKOYAMA, NOMURA, *Sci. Rep., Tôhoku Imp. Univ., Ser. 2, vol. 21, no. 1*, p. 18, pl. 1, figs. 4-7.

The original description of *Pecten notoensis* is as follows.

"Shell of medium size, thick, rather compressed, nearly equivalve, equilateral except for ears, radiately ribbed. Ribs usually five or six near the beak, more or less elevated though rounded, generally smooth, sooner or later dichotomizing either once or twice, with interspaces narrower, in which there is usually an intercalary rib either appearing only near the ventral border or higher up, sometimes more than half way up the shell; number of ribs at ventral border varying, but often more than thirty, counting both larger and small, making inner border unequally serrate. Convexity: presumably nearly equal in both valves of the same individual, but somewhat varying in different ones; equal to from one-fourth to almost one-fifth of height. Ears unequal, anterior larger than posterior, both radiately costellate; byssal notch distinct, acute. Hinge-length less than one half of shell height."

2. 3.

Text-figs. 2–3. Sketch showing the mode of bifurcation of the ribs in *Nanaochlamys notoensis* (YOKOYAMA). 2–Right valve. 3–Left valve. 1/3 natural size.

Description:—Shell of medium size, rather thick, equilateral, subequivalve, moderately inflated, the left valve being nearly flat in the younger stage, but becoming nearly equal or a little more convex than the right valve in the adult; ribs prominent, rounded, smooth and rarely nodulose, numbering six on the right valve, and five on the left in the primordial condition, but soon becoming numerous ventrally by means of both bifurcation and intercalation; on the right valve the primary bifurcation always precedes the primary intercalation and the secondary bifurcation the secondary intercalation; while

on the left valve the primary and also the secondary intercalation precedes the bifurcation of the main ribs, and the tertiary intercalation appears usually a little earlier or rarely at about the same time as the bifurcation of the main ribs, the primary intercalary usually bifurcate ventrally, and the bifurcation of the radials precede the bifurcation of the intercalaries. In general, the radiating ribs become narrow owing to the bifurcation, while the intercalaries become broad ventrally, so that, at the ventral margin the primary and secondary bifurcated radials are nearly equal to the intercalaries in strength. The right valve is regularly convex, with the anterior auricle longer and larger than the posterior, byssal notch shallow and with rarely ill-developed ctenolium; the hinge of both valves usually flat or a little folded, with indistinct cardinal crura and with distinct resilial pit; ribs narrower than the interspaces in the younger stage and becoming broader than the interspaces in the adult stage; the multiplication of ribs ventrally is caused essentially by their bifurcation and only auxiliarily by intercalation; the bifurcation goes up to the tertiary order, and the intercalation to the secondary order, the secondary intercalation occurring in the valleys as a result of the primary bifurcation. The left valve in the adult is convex, abruptly bent at a certain distance from the beak, so as to form a flat platform proximally; the fine primordial ribs rarely form a boss at bending; the anterior auricle is more or less larger than the posterior, provided with a shallow byssal notch; primordinal ribs narrower than the primordinal interspace; multiplication of ribs ventrally caused essentialy by intercalation and only auxiliarily by bifurcation; all the intercalaries occur only in the four primordinal interspaces, the primary intercalaries soon acquire almost the same strength as the primordial ribs and divide ventrally in the same manner; the secondary and tertiary intercalaries, which are on either side of the primary, are weaker but strengthen with continued growth. The outer surface of both valves is very finely radiately and concentrically striated, the auricles of the same are radiately ribbed, the inner surface is folded, corresponding to the ribs and interstices of the outer.

Remarks—From the numerous specimens examined it is noticed that (1) the right valve rarely has an ill-developed ctenolium, (2) the right valve is more convex than the left in the young stage and nearly equal to or a little less convex than the left in the adult stage, (3) the resilial pit in the right valve is deep and provided with distinct lateral ridges, and the resilial pit in the left valve is provided with sockets corresponding to the aforementioned lateral ridge, (4) the hinge of both valves is usually flat and with indistinct cardinal crura, (5) the left valve tends to bend at a distance from the beak and to produce there a platform, (6) the mode of rib-differentiation of both right and left valves are usually constant.

The ribs of this species were described by M. YOKOYAMA as usually numbering five to six near the beak, and by H. MATSUMOTO as six on the right valve and five on the left in the primordinal condition. As a rule, the left valve bears three main stout ribs on the central part of the disc, and two others, that is to say, one on each lateral side; the right valve has four main stout ribs and one on each lateral side.

In the right valve, the relation between shell height and rib-differentiation seems to be a constant feature. The ribs tend to become complex from the younger to the adult, those of the younger stage being usually simple and numbering six, but with continued growth, the main ribs in the central part of the disc usually bifurcate at least twice and an accessory weak, primary intercalary thread is added in the interspace between the main ribs prior to or nearly at the same time the secondary bifurcation commences, or at times even a little later. By continued growth the divided ribs of the first bifurcation again split and intercalaries are added in the same way as in the first case (Text-fig. 2). This mode of multiplication is more or less constant.

In the young stage, the main radials are usually narrower than their interspaces, but with continued growth and multiplication, the radials tend to become subequal to their interspaces in breadth, and in the adult stage, the radials become broader than their interspaces in breadth near the ventral margin and the intercalaries are subequal to the radials in breadth.

The radial ribs are usually round-topped and smooth with broad flattened interspaces, but rarely become somewhat imbricated near the ventral margin owing to the intersection of concentric growth lines.

In the left valve there are three main, stout ribs provided with a weaker one on each lateral side. Before the main ribs bifurcate the first and second intercalary appears, and the third order of intercalary threads appear at about the time the first intercalaries bifurcate. The intercalary threads of the three orders tend to strengthen with continued growth and the first intercalary usually bifucates at the ventral margin with continued growth. (Text-fig. 3).

The lateral ribs of the right valve are usually much narrower than the main ones in the central part of the disc, stronger than the intercalary riblets, and also usually bifurcate. In the left valve, however, the lateral ribs are nearly equal to the main ones in strength although they never become equal or stronger, and also bifurcate similarly as that of the right one. In the lateral marginal region bordering the lateral ribs, several smaller radials develop, but these never become strong or pronounced as the intercalary riblets.

In general, the external surface of the valves of this species is ornamented with obtuse, scaly network, that is to say, in the upper half of both valves, very fine radial striations and similarly strong concentric lines are present on the radial riblets as well as in the interspaces. This network is often obscured and is seen only in well preserved specimens.

Development of concentric lines in the region of the ventral margin of both valves make the radials appear somewhat imbricated.

The auricles are usually sculptured with both distinct radial riblets and fine concentric lines, by which the ornamentation appears imbricated.

In lateral view the convexity of the right valve is more or less uniform with the maximum depth near the middle of the shell length. However, in the left valve the maximum convexity lies dorsal of the middle of the shell length owing to the dorsal part of the valve being more or less flattened. Thus, in the case of specimens with intact valves, the maximum convexity of the right valve is situated in the middle, while that of the left valve is

dorsal to the middle of the shell length, and an oblique line can be drawn by connecting the maximum points of convexity of the valves.

Geological significance — The Nanao formation at Iwaya from where abundant specimens of *notoensis* occur, consists of a richly calcareous sandstone containing abundant pectens, Brachiopoda, Bryozoa, Foraminifera, sponge spicules and balanid fragments. From this sandstone at Iwaya, M. YOKOYAMA (1929) reported *Pecten* (*Patinopecten*?) *kagamianus*, *Pecten notoensis*, *Pecten* (*Chlamys*) *hastatus* SOW. var. *ingeniosa*, *Pecten* (*Chlamys*) *crassiveniis* and *Pecten* sp.

Concerning this sandstone, K. ÔYAMA (1952) stated that it is easily induced that the Nanao formation consists of "the channel sediments" which were deposited when the Noto Peninsula was an island or bank. However, whether the calcareous sandstone should be considered channel sediments is open to question, because the detail paleogeographical conditions at that time have not been worked out. It is evident that *notoensis* lived on a clean sea bottom remote from the influence muddy sediment drained from the land. The depth of the warm water environment is difficult to estimate, although it seems certain that it was beyond the littoral zone.

The Moniwa formation in the southern border of Sendai where *notoensis* is common, consists of granule conglomerate to coarse grained sandstone in which abundant pectens, other pelecypods, some gastropods, echinids, balanids, brachiopods, bryozoan-fragments and rarely shark's teeth occur. This formation at the localities in the southern border of Sendai where *notoensis* occurs is lacking in muddy sediments and from stratigraphical evidence, there is no doubt that the formation represents a transgressive phase by which the total absence of muddy materials may be explained. Although calcareous, the Moniwa formation is not so significant as the Nanao in this respect, but the thermal conditions of the sea in which the two geographically isolated formations were deposited are remarkably similar.

The Ôtsutsumi formation, in the northwest of Sendai, a correlative of the Moniwa, differs in its Pectinidae fauna and *notoensis* is very rare. The Ôtsutsumi consists of tuffaceous, very coarse sandstone or conglomeratic sandstone in which muddy material is embedded. Although the thermal conditions in which the Ôtsutsumi was deposited is similar to that of both the Moniwa and the Nanao, the ecological conditions seem to have been different as can be noticed from its paucity of calcareous sediments. Therefore, it is inferred that *notoensis* flourished only in environments consisting of a clear sea bottom influenced by warm thermal conditions, and that its absence or rarity in correlative formations may be explained, in part, by such reason.

Nanaochlamys notoensis under the generic names of *Pecten* or *Chlamys* has been reported from the Nanao, Takasegawa, Daijima, Setana, Moniwa, Ôtsutsumi, Chiganoura, Yanagawa, Shioda and Hatatate formations, but not all of them have been figured thus leaving one in doubt as to their details. This species has also been recorded from Ennichi in South Korea. Of the named formations, the species is very rare in the Hatatate formation in the southern region of Sendai, and in the Chiganoura formation developed around Shiogama City, both in Miyagi Prefecture. It is

also not common in the formations other than those of Nanao and Moniwa, probably owing to both bottom control and geological horizon. Its record from the Setana formation was not confirmed.

From the geological distribution and range, it is inferred that this species attained its maximum flourishing, which seems to have been very short, during the Early Miocene, that is to say, in a two-fold division of the Miocene.

References

DALL, W. H., BARTSCH, P. & REHDER, H. A. (1938): A Manual of the Recent and Fossil Marine Pelecypod Mollusca of the Hawaiian Islands. *Bishop Mus. Bull., no. 153*, p. 88.

GRANT, U. S. & GALE, H. R. (1931): Pliocene and Pleistocene Mollusca of California. *Mem. San Diego Soc. Nat. Hist. vol. 1*, pp. 161-163.

IREDALE, T. (1929): Mollusca from the Continental Shelf of Eastern Australia, no. 2. *Rep. Austr. Mus., no. 17*, pp. 162-164, pl. 38, figs. 7, 8, 9.

——, (1939): Great Barrier Reef Exped. 1928-29. *Sci. Rep., vol. 5, no. 6, Mollusca, pt. 1*, pp. 354-355.

HATAI, K. (1938): A Review of the Paleontology of Akita Prefecture (Ugo province). *Japan. Jour. Geol. Geogr., vol. 15, nos. 1-2*, p. 38.

HAYASHI, T. (1946): On the Geomorphlogy and Geology of Western Border of Yamizo Mountains. *Graduation Thesis of the Tôhoku University.*

KANEHARA, K. (1953): On the Geologic Age of the Ennichi Series. *Jour. Geol. Soc. Japan, vol. 42, no. 501*, pp. 334-335.

KUBOTA, K. (1950): Fossil Pectinidae from the Setana Series, (Studies of the Fossil Fauna from Setana Series, no. 3). *Cenozoic Studies, Sapporo, no. 6*, p. 17, pl. 9, fig. 74.

KURODA, T. (1932): *The Venus, vol. 3, no. 2, Appendix*, p. 90.

MATSUMOTO, H. (1930): On the Marine Fauna of Three Fossil Zones of the Upper Miocene of Natori district, Province of Rikuzen. *Sci. Rep. Tôhoku Imp. Univ., Ser. 2, vol. 13, no. 3*, pp. 104-105, pl. XL, figs. 10, 11, 12, 13, 14.

NAKAMURA, M. (1940): On Some Pectinidae Fossils from the Miocene Deposits of the Tomiya Block, Miyagi-ken, Northeast Honshu, Japan. *Jap. Jour. Geol. Geogr., vol. 17, nos. 1-2*, pp. 8-9.

——, (1935): Miocene Mollusca from Shiogama, Northwest Honsyu, Japan. *Saito Ho-on Kai Mus., Res. Bull., no. 6*, pp. 196-197.

——, (1940): Molluscan fauna of the Moniwa Shell bed exposed along the Natorigawa in the Vicinity of Sendai, Miyagi Prefecture, Japan. *Sci. Rep., Tôhoku Imp. Univ., Ser. 2, vol. 21, no. 1*, pp. 18-19, pl. 1, figs. 4, 5, 6, 7.

NOMURA, H. and ZINBO, N. (1935): Mollusca from the Yanagawa Shell Beds in the Fukushima Basin, Northeast Honsyu, Japan. *Saito Ho-on Kai, Mus., Res. Bull., no. 6*, pp. 161-162, pl. 15, fig. 27.

ÔTUKA, Y. (1935): The Oti Graben in southern Noto Peninsula, Japan. pt. 3. *Bull. Earthquake Res. Inst., Tôkyo Imp. Univ., vol. 13, pt. 4*, p. 886.

——, (1936): The Takasegawa Green Tuff Beds of the Yuri District, Akita Pref. Japan, and Correlation of the Lower Neogene in Japan. *Bull. Earthquake Res. Inst., Tôkyo Imp. Univ., vol. 14, pt. 3*, pp. 442-443.

ÔYAMA, K. (1952): Paleoecological Studies on Pectens. *Miscellaneous Reports of the Res. Inst. Nat. Res., no. 5*, p. 28.

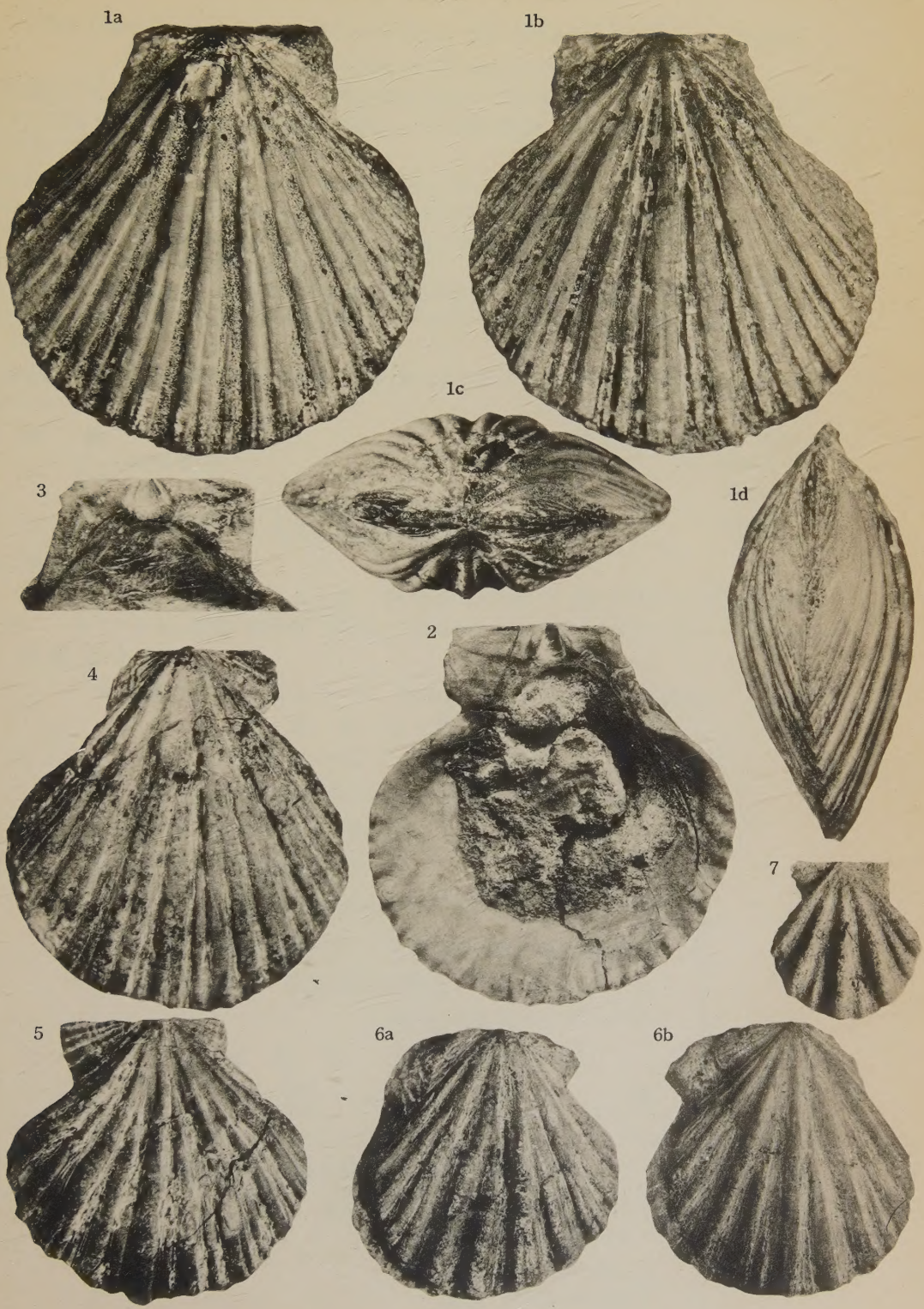
YOKOYAMA, M. (1929): Pliocene shells from near Nanao, Noto. *Imp. Geol. Surv. Japan, Rep. 104*, pp. 4 5, pl. 3, figs. 1, 2, 3, 4, pl. 4, figs. 1, 2. pl. 5, figs. 1, 2.

YABE H. and HATAI, K. (1941): The Cenozoic Formations and fossils of Northeast Honsyu, Japan. *Sci. Rep., Tôhoku Univ., Ser. 2, vol. 22, no. 1.*

Explanation of Plate 7

Nanaochlamys notoensis (YOKOYAMA).

Figs. 1. a. Right valve, ×1.
b. Left valve, ×1.
c. Upper view of the same, ×1.
d. Side view of the same, ×1.
Fig. 2. Internal view of right valve, ×1.
Fig. 3. Hinge area of left valve, ×1.
Fig. 4. Right valve, ×1.
Fig. 5. Left valve, ×1.
Fig. 6a-b. a. Right valve, ×1. b. Left valve of the same, ×1.
Loc. Kumanodô, Takadate-mura, Natori-gun, Miyagi Prefecture. Moniwa formation.
Fig. 7. Left valve of younger stage, ×1.
Loc. Iwaya, Nanao City, Ishikawa Prefecture. Nanao formation.



K. KUMAGAI photo.

1953 年 9 月 25 日　印　刷
1953 年 9 月 30 日　發　行

定價（會員外の方本號に限り）1 部 200 圓

編集兼發行者　東京大學理學部地質學教室內
日本古生物學會　小 林 貞 一
（振替口座東京 84780 番）

印 刷 者　東京都港區芝浦 1 丁目 1
株式會社 ヘラルド社　富 田　元

CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

ARTICLE 1. Name

The Society shall be known as the Palaeontological Society of Japan. The Society is a section of the Geological Society of Japan.

ARTICLE 2. Object

The object of the Society shall be to promote the study of palaeontology and related sciences.

ARTICLE 3. Achievement

The Society in order to execute Article 2 shall (a) issue the Society journal and other publications, (b) hold or sponsor scientific lectures and meetings, and (c) sponsor collecting or field trips, and lectures.

ARTICLE 4. Membership

The Society shall be composed of persons who are active of interested in palaeontology or related sciences, and shall be known as regular members, honorary members, and patrons.

ARTICLE 5. The members of the Society shall be obliged to pay annual dues to the Society, for which they shall enjoy the privilege of receiving the Society's journal and of submitting papers which have been read and discussed at the meetings for publication in the Society's journal.

ARTICLE 6. Administration

The Society shall have the following organizations for its administration.

(a) General meeting. The general meeting shall be composed of the Society members. More than one tenth of regular members shall be present to hold general meetings. Administrative affairs shall be decided during the general meeting.

(b) President. The president shall be elected from among the regular members. The president shall represent the Society and supervise its business matters.

(c) Council. The council shall be composed of councillors who are elected from among the regular members. The council shall discuss administrative affairs.

(d) Business council. The business councillors shall be elected from among the council members, and shall administer business affairs.

(e) Officers shall be elected by vote of returned mail ballots, as a general rule.

ARTICLE 7. Amendments to the constitution shall be by decision of the general meeting.

By-Laws and Administration

ARTICLE 8. The Society's journal shall be issued three times a year.

ARTICLE 9. Regular members shall be persons who have knowledge, experience, or interest in palaeontology or related sciences.

ARTICLE 10. Patrons shall be selected individuals or organizations who give special support to the objectives of the Society.

ARTICLE 11. Honorary members shall be persons of distinguished achievement in palaeontology. The council shall nominate honorary members for decision by the general meeting.

ARTICLE 12. Applicants for membership to the Society shall submit their full name, mailing address, date of birth, occupation, and name of school from which they graduated.

Dues

ARTICLE 13. Rates for annual dues of the Society shall be decided during the general meeting. Annual dues for regular members is Yen 400.00 (domestic members) and U.S. $2.00 (foreign members). Patrons are individuals or organizations donating more than Yen 10,000.00 annually. Honorary members are free from obligations.

ARTICLE 14. The Society income shall be from membership dues and bestowals.

ARTICLE 15. The Society shall have one chairman, fifteen councillors, and several business councillors, whose term of office shall be two years. They may be re-elected.

Addendum

ARTICLE 1. There shall be four business councillors for the present.

ARTICLE 2. The Society journal shall be issued three times a year for the present.